

New species and records of the Papuan Diplommatinidae (Caenogastropoda: Cyclophoroidea)

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Abstract: Six species of *Palaina* O. Semper, 1865 (Diplommatinidae L. Pfeiffer, 1856) new to science are described and illustrated from the Papuan biogeographical region, namely *P.* (s. l.) *cenderawasih*, *P.* (s. l.) *evanescens*, *P.* (s. l.) *kagainisi*, *P.* (s. l.) *pallgergelyi*, *P.* (s. l.) *sarmi* and *P.* (s. l.) *saxatilis* spp. nov. New distribution records are provided for ten poorly known *Palaina* species. An updated key to the Papuan Diplommatinidae is presented.

Key words: Taxonomy, key, *Palaina*, Papuan Region, New Guinea, Biak, ecology.

Introduction

The Diplommatinidae L. Pfeiffer, 1856 are minute (1–10 mm) terrestrial caenogastropod snails distributed in subtropical and tropical Asia (SE Palaearctic and Oriental regions), north-eastern Australia, the Papuan Region, Pacific islands, and Central and South America (Egorov 2013). The diplommatinid fauna of the Papuan biogeographical region and Wallacea was revised recently by Greke (2017), and is considered highly diverse and comprised of 121 species in the genera *Arinia* H. et A. Adams, 1856 (five species), *Diancta* Martens, 1864 (five species), *Diplommatina* s. l. Benson, 1849 (22 species), *Moussonina* O. Semper, 1865 (12 species), and *Palaina* O. Semper, 1865 (77 species) (Greke 2017). Approximately 98% of the Papuan diplommatinid species are considered local and regional endemics with restricted ranges usually associated with limestone outcrops in primary rainforest habitats (Greke 2017).

Recent material provided for current study by the Natural History Museum in Erfurt (Germany) and Michael Kesi (Prague, Czech Republic) contains new data on several poorly known species from the Central Moluccas, northern New Guinea, and Biak Island. Six new species are described: *Palaina* (s. l.) *cenderawasih*, *P.* (s. l.) *evanescens*, *P.* (s. l.) *kagainisi*, *P.* (s. l.) *pallgergelyi*, *P.* (s. l.) *sarmi* and *P.* (s. l.) *saxatilis* spp. nov. As a result of this study, the total number of *Palaina* species in the Papuan Region and Wallacea reaches 83 and the total number of diplommatinid species in Wallacea and the Papuan Region – 127 species. New

distributional records of ten poorly known species are presented. Scanning electron micrographs (SEM) of shell sculpture, especially spiral raised striae, is presented for the first time for some of discussed taxa.

Material and methods

All taxa are listed alphabetically, because a phylogenetic arrangement is currently impossible. All label text is reproduced without additions. All labels are printed. Author's comments are placed in square brackets. Type specimens of new species described in the present publication are provided with an additional black-framed printed label “Holotypus” or “Paratypus” on red paper.

Most specimens described below are preserved in 99% ethanol. A Leica S6D stereomicroscope was used for dissection and study. Shell images were taken using a Canon EOS 77D SLR camera attached to the stereomicroscope. CombineZP software was used for image stacking (Hadley 2010). Further image manipulations were done in GNU Image Manipulation program (GIMP). Scanning electron microscope (SEM) images were taken using SEM provided by the Latvian University's Faculty of Biology. Shells were ultrasonically cleaned in distilled water for 1–2 minutes, washed through a graded alcohol series up to 99%, air dried and placed dorsally onto conductive tape on aluminium stubs. Shells were imaged using a Hitachi TM-3000 (Hitachi High Technologies ®) SEM following methods as described by Geiger *et al.* (2007).



The internal lamellar system was exposed using entomological pins (size 1 or 3 depending on the dimensions of the shell).

The morphological terminology introduced by Liew *et al.* (2014), supplemented by Neubert & Bouchet (2015) and Greke (2017) is used for descriptions. Shell size classes and measurements follow Greke (2017) except that aperture diameter was measured instead of peristome width. The following measurements were taken for all species: shell height, height of the ultimate whorl, maximum shell width, and maximum diameter of aperture.

Holotypes of the newly described species are deposited at the Natural History Museum (Naturkundemuseum) in Erfurt, Germany. Additional specimens are deposited in the Museum Zoologicum Bogoriense (see details in the text).

The Papuan Region as considered here is a zoogeographic term in the sense of Gressitt (1982), Beehler *et al.* (1986), Riedel (2002), and Telnov (2011).

Abbreviations and acronyms used in the text:

AD – maximum diameter of aperture;
 env. – environs;
 KGC – Collection Kristine Greke, Dzidriņas, Latvia;
 H – shell height including the peristome;
 HW – height of ultimate whorl;
 Is. – island;
 juv. – juvenile (not adult or subadult) specimen;
 vill. – village or little settlement;
 MBBJ – Research Center for Biology, Indonesian Institute of Sciences, Cibinong, Indonesia;
 MKC – Collection Michael Kesi, Prague, Czech Republic;
 NME – Naturkundemuseum Erfurt, Germany.

Results

New records

***Moussonina strubelli* (O. Boettger, 1891)**

New material: Indonesia, Maluku, Is. Ambon Halong, under trees by the stream I 0035 21.1.2012 Igt.M.Kesi [1 adult, MKC].

***Palaina* (s. l.) *angulata* O. Boettger, 1891**

New material: Indonesia, Maluku, Is. Ambon Halong, under trees by the stream I 0003 21.1.2012 Igt.M.Kesi [5 adults, MKC].

***Palaina* (s. l.) *ascendens* (Martens, 1864)**

New material: Indonesia, Maluku, Is. Ambon Halong, under trees by the stream I 0002 21.1.2012 Igt.M.Kesi [3 adults, MKC].

***Palaina* (s. l.) *citrinella* van Benthem Jutting, 1963** (Figs 1 & 14)

New material: INDONESIA E, New Guinea, Papua Prov., Sentani 30 km W, road to Nimbokrang, River Armo valley, 02°34'26"S, 140°14'21"E, 62-65 m, 31.III.2018, wet limestone rocks at riverbank [29 adults, 6 subadults, 8 juv., MBBJ, NME & KGC] (Map 1).

Measurements: Selected adult specimen H = 3.7 mm, W = 1.9 mm, HW = 2 mm, AD = 1 mm.

Additional description: Columella glossy, straight, with no knob or callus. Operculum derivative, with concentric ridges on outer surface. Shell microstructure as in Fig. 14.

Ecology: Specimens sampled from wet, in part mossy rocks and from leaf litter in river valley in disturbed lowland (elevation 62–65 m) rainforest.

Distribution: Northern West New Guinea, Sentani - Genjem area. First record since the original description.

***Palaina* (s. l.) *consobrina* van Benthem Jutting, 1963** (Fig. 15)

New material: INDONESIA E, New Guinea, Papua Prov., Jayapura 21 km SSE, Koya Tengah 1-2 km NNW, 02°37'57"S, 140°48'59"E, 50-80 m, 18.III.2018, secondary lowland rainforest on limestone [NME & KGC, 2 adult & 6 juv. specimens] (Map 1).

Measurements: Selected adult specimen H = 4.5 mm, W = 3 mm, HW = 2.2 mm, AD = 3.4 mm.

Chirality: One of studied adult specimens is dextral.

Additional description: Columellar knob large, somewhat shifted towards base of columella, turned outwardly in direction of apertural opening. Shell microstructure as in Fig. 15.

Ecology: Specimens sampled from wet leaf litter in disturbed lowland (elevation 50–80 m) rainforest on a limestone ridge.

Distribution: Jayapura & Sentani areas, northern West New Guinea. First record since the original description, first record from E of Jayapura. Considering peculiarities of the landscape in the boundary area between Indonesian New Guinea and Papua New Guinea (presence of West-to-East directed limestone ridges), this species is likely to occur in Papua New Guinea as well (Vanimo area in particular).

***Palaina* (s. l.) *cupulifera* van Benthem Jutting, 1963** (Figs 2 & 16)

New material: INDONESIA E, Papua Prov., Cenderawasih Bay, Biak Is. E, Biak ~34 km ENE, 01°04'50"S, 136°22'08"E, 10-15 m, 22.III.2018,



primary lowland rainforest [NME & KGC, 2 adult specimens] (Map 2).

Measurements: Adult specimen H = 4 mm, W = 2.5 mm, HW = 2.5 mm, AD = 2.2 mm.

Additional description: Shell microstructure as in fig. 16.

Ecology: Specimens sampled from wet leaf litter in a small remaining patch of primary lowland rainforest (elevation 10–15 m) on limestone soil, immediately near the mangrove zone.

Distribution: Eastern part of Biak Is., Cenderawasih Bay Islands. First record since the original description, first record from eastern tip of Biak.

***Palaina* (s. l.) *glabella* van Benthem Jutting, 1963**
(Figs 3 & 18)

New material: INDONESIA E, Papua Prov., Cenderawasih Bay, Biak Is. N, Biak ~53.5 km NNW, 0°44'38"S, 135°52'55"E, 150–260 m, 22.III.2018, primary lowland rainforest on limestone rocks [NME & KGC, 2 adult specimens]; INDONESIA E, Papua Prov., Cenderawasih Bay, Biak Is. N, Biak ~56 km NNW, 0°42'40"S, 135°51'59"E, 95–120 m, 22.III.2018, primary lowland rainforest on limestone rocks [NME & KGC, 2 adult & 1 juv. specimens] (Map 2).

Measurements: Selected adult specimen H = 3.6 mm, W = 2.25 mm, HW = 2 mm, AD = 1.7 mm

Additional description: Spiral raised striae present, delicate, there are 4–5 ribs per 100 µm (Fig. 18). Columella glossy, straight, no knob or callus present. Operculum derivative, with low concentric ridges on outer surface.

Ecology: Specimens sampled from wet leaf litter and limestone rock cavities in primary lowland (elevation 95–260 m) rainforest on limestone soil.

Distribution: Southern ("Base Biak", W of Sorido (Soredo)) and northern Biak, Cenderawasih Bay Islands. First records since the original description, first record from northern part of Biak.

***Palaina* (s. l.) *inconspicua* van Benthem Jutting, 1963**
(Figs 4 & 19)

New material: INDONESIA E, Papua Prov., Cenderawasih Bay, Biak Is. W, Biak ~16 km W, Urfu vill., 01°09'12"S, 135°55'53"E, 3–15 m, 21.III.2018, secondary lowland rainforest on coastal rocks [KGC, 1 adult specimen] (Map 2).

Additional description: Spiral raised striae present, there are 3–6 very delicate spiral raised striae between every two stronger ones (Fig. 19), there are 3–4 stronger and up to 10 very delicate

ribs per 100 µm.

Ecology: Specimens sampled from wet leaf litter and limestone rock cavities in primary lowland (elevation 50–580 m) rainforest on limestone soil.

Distribution: Southern parts of Biak Is. and Owi Is. S offshore Biak, Cenderawasih Bay Islands. First record since the original description.

***Palaina* (s. l.) *lilliputana* van Benthem Jutting, 1963**
(Figs 5 & 22)

New material: INDONESIA E, Papua Prov., Cenderawasih Bay, Biak Is. N, Biak ~53.5 km NNW, 0°44'38"S, 135°52'55"E, 150–260 m, 22.III.2018, primary lowland rainforest on limestone rocks [NME & KGC, 11 adult specimens]; INDONESIA E, Papua Prov., Cenderawasih Bay, Biak Is. N, Biak ~60 km NNW, 0°43'23"S, 135°48'13"E, 50–580 m, 22.III.2018, primary lowland rainforest on limestone rocks [KGC, 2 adult specimens]; INDONESIA E, Papua Prov., Cenderawasih Bay, Biak Is. N, Biak ~56 km NNW, 0°42'40"S, 135°51'59"E, 95–120 m, 22.III.2018, primary lowland rainforest on limestone rocks [MBBJ, NME & KGC, 66 adult & 2 juv. specimens] (Map 2).

Additional description: Shell microstructure as in Fig. 22.

Ecology: Specimens sampled from wet leaf litter and limestone rock cavities in primary lowland (elevation 50–580 m) rainforest on limestone soil.

Distribution: Southern and northern parts of Biak Is., Cenderawasih Bay Islands. First records since the original description.

***Palaina* (s. l.) *repandostoma* van Benthem Jutting, 1963**
(Fig. 23)

New material: INDONESIA E, Papua Prov., Cenderawasih Bay, Biak Is., Biak ~11 km E, at Biak Bird park, 01°10'39"S, 136°10'33"E, 40–70 m, 21.III.2018, primary lowland rainforest on limestone [MBBJ, NME & KGC, 28 adult specimens] (Map 2).

Measurements: Selected adult specimens H = 3 mm, W = 2 mm, HW = 1.5 mm, AD = 1.5 mm; H = 2.9 mm, W = 1.9 mm, HW = 1.7 mm, AD = 1.5 mm.

Additional description: Shell microstructure as in fig. 23.

Ecology: Specimens sampled from wet leaf litter in primary lowland (elevation 40–70 m) rainforest at foot of a steep limestone ridge.

Distribution: Southern ("Base Biak", W of Sorido (Soredo)) part of Biak Is., Cenderawasih Bay Islands. First record since the original description.



New descriptions

***Palaina* (s. l.) *cenderawasih* sp. nov.** (Figs 6, 12–13)

<http://zoobank.org/EF29B6A0-C1B5-4FB8-91CC-212F71508C9B>

Holotype NME: INDONESIA E, Papua Prov., Cenderawasih Bay, Biak Is., Biak ~11 km E, at Biak Bird park, 01°10'39"S, 136°10'33"E, 40–70 m, 21.III.2018, primary lowland rainforest on limestone.

Paratypes 27 specimens: 9 adult specimens [1 MBBJ, 3 NME & 5 KGC] same data as holotype [one paratype shell badly broken]; 16 adult & 2 juv. specimens [11 NME, 5 adults & 2 juv. KGC] INDONESIA E, Papua Prov., Cenderawasih Bay, Biak Is. W, Biak ~16 km W, Urfu vill., 01°09'12"S, 135°55'53"E, 3–15 m, 21.III.2018, secondary lowland rainforest on coastal rocks.

Derivatio nominis: Named after Cenderawasih Bay of New Guinea, where Biak Island (locus typicus) is situated. In Indonesian “cenderawasih” means Bird of Paradise, a group of iconic New Guinean birds. Noun in apposition.

Measurements: Holotype H = 2.5 mm, W = 1.5 mm, HW = 1.5 mm, AD = 1.1 mm. Selected paratypes H = 2.5 mm, W = 1.5 mm, HW = 1.35 mm, AD = 1.05 mm; H = 2.4 mm, W = 1.5 mm, HW = 1.4 mm, AD = 1 mm; H = 2.4 mm, W = 1.55 mm, HW = 1.5 mm, AD = 1.1 mm.

Description: Shell small, pale pink to yellowish, sinistral, subcylindrical with prominent (projecting) apex. Shell of 5 moderately strongly convex whorls, 1½ embryonic whorls are microscopically pitted, pits arranged in irregular axial rows. Suture is deeply impressed. Ultimate whorl is slightly wider than penultimate whorl in apertural view. Umbilicus is closed in adults. Constriction is moderately well defined by denser axial ribs and a deep impression on suture above constriction. Position of constriction is above columellar side of aperture. Teleoconch is sculptured with moderately widely spaced nearly straight axial ribs. Ribs are twice as dense around constriction, but gradually becoming more distant (up to twice as distant as on earlier whorls) on last half whorl, without abrupt changes in ribbing pattern. Ribs are not synchronous with those on previous whorls and are slightly oblique to coiling axis. There are 6–7 ribs per 0.5 mm on penultimate whorl in abapertural view. Spiral raised striae of teleoconch very delicate; at 500x magnification per 100 µm there are 1–12 rows of spiral raised striae present on penultimate whorl but only 4–5 on ultimate whorl before constriction area. Aperture is circular, tilted about 10° to coiling axis, apertural rim is entire. Aperture is slightly shifted left of

coiling axis in apertural view. Peristome is double, in lateral view narrow. Outer peristome is formed by two nearly same strongly developed lamellae of previous peristomes (peristome therefore looks triple in lateral view). Peristome is complex, outer peristome looks double since prominent lamellar edge of previous peristome is narrowly attached to it. Outer peristome slightly expanding beyond inner peristome. Parietal margin of peristome is attached to spire. Inner peristome forms a narrow, continuous, polished callus, is entire and appressed to penultimate whorl. Outer peristome is discontinuous along parietal margin. Margins of peristome are not sinuous, or in some paratypes only palatal margin of outer peristome is slightly sinuous. Columella is smooth and straight, without knob or callus. Operculum is derivative, with low concentric ridges on outer surface.

Sexual dimorphism: Dimorphism is remarkable in this species, female shell more globose and less elongate than male.

Differential diagnosis: The new species is most similar to *Palaina glabella* van Benthem Jutting, 1963 (Biak Is.), but is readily differentiated by its smaller shell size (H = 3.4–3.9 mm in *P. glabella*), the sparser spiral raised striae (up to 5–6 spiral raised striae per 100 µm at 300x magnification in *P. glabella*) with the two kinds of the spiral raised striae – stronger sparse and slightly denser (only one kind of the spiral raised striae in *P. glabella*), the axial ribs significantly denser at the constriction area (not in *P. glabella*), the outer peristome consists of two equally developed lamellae of the previous peristomes (the peristome double in *P. glabella*, the outer peristome consists of one or two merged lamellae), all margins of the outer peristome nearly equally strongly developed (the columellar and the palatal margins of the outer peristome stronger, somewhat protruding from the generally circular outline of the peristome in *P. glabella*).

Ecology: Specimens sampled from wet leaf litter in primary lowland (elevation 40–70 m) rainforest at foot of a steep limestone ridge and from cavities in coastal limestone rocks (elevation 3–15 m).

Distribution: South of Biak Island (Map 2).

***Palaina* (s. l.) *evanescens* sp. nov.** (Figs 7 & 17)

<http://zoobank.org/5CA18249-0F99-4730-954C-D0D580ECC94B>

Holotype NME: INDONESIA E, New Guinea, Papua Prov., Jayapura 21 km SSE, Koya Tengah 1–2 km NNW, 02°37'57"S, 140°48'59"E, 50–80 m, 18.III.2018, secondary lowland rainforest on limestone.

Paratype 1 adult KGC: same data as holotype.



Derivatio nominis: Named from Latin “evanescere” [disappear, vanish, evaporate] to highlight that native habitats at the type locality of this species are surrounded and are being replaced by expanding human settlements.

Measurements: Holotype H = 3.8 mm, W = 2.5 mm, HW = 2.2 mm, AD = 1.7 mm. Paratype H = 3.7 mm, W = 2.3 mm, HW = 1.7 mm, AD = 1.55 mm.

Description: Shell is sinistral, small, whitish with pale orange to brownish apical whorls, and broadly cylindrical with prominent (projecting) apex. Shell with $6\frac{1}{2}$ strongly convex whorls, $1\frac{1}{4}$ embryonic whorls are microscopically pitted. Suture is deeply impressed. Ultimate whorl is about as wide as penultimate whorl in apertural view. Umbilicus is closed in adult. Constriction is well defined by presence of a vague impression on shell wall, denser pattern of axial ribs, and presence of an impression on suture above constriction. Position of constriction is above columellar side of aperture. Teleoconch is sculptured with moderately widely spaced and strongly sinuous axial ribs. Ribs abruptly become coarser and twice as distant on last half whorl beyond constriction. Ribs are not synchronous with those of previous whorls and are slightly oblique to coiling axis. There are 6–7 ribs per 0.5 mm on penultimate whorl in abapertural view. Spiral raised striae not observed at 300x magnification. Aperture is not tilted to coiling axis, is circular, with entire apertural rim. Aperture is shifted left of coiling axis in apertural view. Peristome is simple in lateral view. Parietal margin of peristome is attached to spire. Inner peristome forms narrow, continuous, polished callus, is entire and appressed to penultimate whorl. Outer peristome discontinuous along parietal margin. Peristome margins broadly expanded, not sinuous except slightly sinuous palatal margin. Columella is smooth and glossy, without knob or callus. Operculum unknown.

Differential diagnosis: *Palaina evanescens* sp. nov. is readily differentiated from its Papuan congeners by the combination of the following features: the peristome is simple, the aperture shifted left to the coiling axis, the axial ribs becoming twice as distant beyond the constriction on the last half whorl, the axial ribs distinctly sinuous, the columella simple. For similar species see modified key below.

Ecology: Specimens sampled from wet leaf litter in disturbed lowland (elevation 50–80 m) rainforest on a limestone ridge.

Distribution: Northern New Guinea (Map 1).

***Palaina* (s. l.) *kagainisi* sp. nov.** (Figs 8, 20–21)

<http://zoobank.org/B73DD905-488E-4996-AF8B-7E6E2CE2DFBE>

Holotype NME: INDONESIA E, Papua Prov., Cenderawasih Bay, Biak Is. N, Biak ~53.5 km NNW, $0^{\circ}44'38''S$, $135^{\circ}52'55''E$, 150–260 m, 22.III.2018, primary lowland rainforest on limestone rocks.

Derivatio nominis: Patronymic. This species named after Dr. Uģis Kagainis (University of Latvia Faculty of Biology, Rīga), well-known acarologist and collaborative colleague, who is specialized on advanced microscopy methods.

Measurements: Holotype H = 2.3 mm, W = 1.4 mm, HW = 1.4 mm, AD = 0.75 mm.

Description: Shell small, white, sinistral, subcylindrical with flattened apex. Shell of five strongly convex whorls, first embryonic whorl is microscopically pitted. Suture is deeply impressed. Ultimate whorl is slightly wider than penultimate whorl in apertural view. Umbilicus is closed in adults. Constriction is strongly defined by a denser pattern of axial ribs and presence of a deep impression on suture above constriction. Position of constriction is above parietal side of aperture. Teleoconch is sculptured with widely spaced, nearly straight, high axial ribs. Ribs become twice as dense around constriction, but thereafter rapidly becoming as widely spaced as before constriction. There are abrupt changes in ribbing pattern at constriction area. Ribs are not synchronous with those on previous whorls and are slightly oblique to coiling axis. Ribs increase in height towards suture. There are ~4 ribs per 0.5 mm (or 8–9 per 1 mm) on penultimate whorl in abapertural view. Spiral raised striae of teleoconch very delicate and barely visible at 500x magnification; there are about 16–17 delicate spiral raised striae per 100 μ m on penultimate whorl. Aperture is not tilted to coiling axis, is circular and with entire apertural rim. Position of aperture is nearly centered in apertural view. Peristome is double; outer peristome consists of three or more nearly equally strongly developed lamellae of previous peristomes, therefore peristome looks multilamellate in lateral view. Outer peristome is more strongly developed than inner peristome. Parietal margin of peristome is attached to spire. Inner peristome forms a narrow continuous polished callus. Inner peristome entire, appressed to penultimate whorl, outer peristome discontinuous along parietal margin. Margins of peristome are not or slightly sinuous. Columella is smooth and straight, widened towards base, without knob or callus. Operculum derivative, with 4–5 low,



concentric ridges and somewhat impressed central area on outer surface.

Differential diagnosis: The new species is most close to *Palaina glabella* van Benthem Jutting, 1963 (Biak Is.), but is readily differentiated by the smaller shell size ($H = 3.4\text{--}3.9$ mm in *P. glabella*), the significantly denser axial ribbing pattern at the constriction area, the nearly absent spiral raised striae, the multilamellate peristome (the peristome is double in *P. glabella*), the nearly equally developed margins of the outer peristome (the columellar and the palatal margin of the outer peristome stronger developed, somewhat protruding from generally circular outline of the peristome in *P. glabella*).

Ecology: Specimens sampled from cavities of limestone rock in primary lowland (elevation 150–260 m) rainforest on limestone.

Distribution: Southern part of Biak Island (Map 2).

***Palaina* (s. l.) *pallgergelyi* sp. nov.** (Fig. 9)

<http://zoobank.org/A7228052-0184-4030-B27C-14F7009BCD0B>

Holotype NME: INDONESIA E, Papua Prov., Cenderawasih Bay, Biak Is. N, Biak ~53.5 km NNW, $0^{\circ}44'38''\text{S}$, $135^{\circ}52'55''\text{E}$, 150–260 m, 22.III.2018, primary lowland rainforest on limestone rocks [shell is damaged as on the images].

Derivatio nominis: Patronymic. This species honours Barna Páll-Gergely (Department of Biology, Shinshu University, Japan), famous malacologist and collaborative colleague, for his work in malacology.

Measurements: Holotype $H = 4.4$ mm, $W = 2.6$ mm, $HW = 2.2$ mm, $AD = 1.7$ mm.

Description: Shell large, colourless (discoloured old shell), sinistral, fusiform with prominent (projecting) apex. Shell of six moderately strongly convex whorls, first $1\frac{1}{2}$ embryonic whorls are microscopically pitted. Suture is moderately deeply impressed. Ultimate whorl is slightly narrower than moderately bulbous penultimate whorl in apertural view. Umbilicus is closed in adults. Exact position of constriction is not determined (the only available shell is damaged). Shell with moderately strong (obsolete angulate) bulb beyond presumable area of constriction. Post-constriction area with denser pattern of axial ribs. Presumable position of constriction is above columellar side of aperture. Teleoconch is sculptured with dense, strongly sinuous (on older whorls) to nearly straight (part of penultimate and ultimate whorls) axial ribs. Ribs becoming almost twice as dense between

constriction and bulb, but gradually becoming more distant (up to twice as distant as on earlier whorls) on last half whorl, without abrupt changes in ribbing pattern. Ribs are not synchronous with those of previous whorls and are strongly oblique to coiling axis. There are about 9–12 ribs per 0.5 mm on penultimate whorl in abapertural view. Spiral raised striae or ribs not present. Aperture is not tilted to coiling axis, is circular. Apertural rim appears entire. Aperture is slightly shifted left of coiling axis in apertural view. Peristome is double, in lateral view moderately broad and with several delicate, dense previous peristomes. Outer peristome is less strongly developed than inner one. Parietal margin of peristome is attached to spire. Inner peristome forms a narrow, continuous, polished callus. Outer peristome is not entire, broadly discontinuous parietally. Columellar margin of peristome slightly sinuous. Columella is smooth and straight with large, glossy median knob. Operculum primitive, slightly impressed on outer surface, without ridges. Differential diagnosis: Hitherto the largest diplommatinid species on Biak, *P. pallgergelyi* sp. nov. is most similar to *P. consobrina* van Benthem Jutting, 1963 (Biak Is.) but readily distinguishable from congeners due to the combination of the following features: the shell H over 4 mm, the axial ribbing pattern dense, becoming only slightly more distant on the last half whorl, the axial ribs strongly sinuous on the older whorls but nearly straight on the last two whorls, the outer peristome is less strongly developed than the inner one, the columellar knob is large and positioned medially, the operculum primitive.

Ecology: Specimen sampled from cavities of limestone rock in primary lowland (elevation 150–260 m) rainforest on limestone.

Distribution: Northern part of Biak Island (Map 2).

***Palaina* (s. l.) *sarmi* sp. nov.** (Figs 10 & 24)

<http://zoobank.org/B0A07027-693A-4FB1-990E-2D4B53E17A>

Holotype NME: INDONESIA E, New Guinea, Papua Prov., Sarmi 18 km SSE, $01^{\circ}58'12''\text{S}$, $138^{\circ}51'21''\text{E}$, 50–65 m, 27.III.2018, primary lowland rainforest on limestone.

Paratype 1 subadult KGC: same data as holotype [the paratype shell is broken, apertural part missing].

Derivatio nominis: Named after Sarmi, the main town and the language family in the area, where this species was first collected. Noun in apposition. Measurements: Holotype $H = 2.6$ mm, $W = 1.4$ mm, $HW = 1.3$ mm, $AD = 1.1$ mm.



Description: Shell small, light yellow with darker yellow protoconch, sinistral, broadly fusiform with prominent projecting apex. Shell of 5½ moderately strongly convex whorls, 1½ embryonic whorls are microscopically pitted. Suture is deeply impressed. Ultimate whorl is about as wide as penultimate whorl in apertural view. Umbilicus is closed in adults. Constriction is defined by presence of a vague impression on shell wall, somewhat denser pattern of axial ribs and presence of a deep impression on suture above constriction. Constriction is slightly shifted to columellar side of aperture. Teleoconch is sculptured with moderately widely spaced, straight to slightly sinuous axial ribs. Ribs become coarser and more distant on last half whorl, but without abrupt changes in ribbing pattern. Ribs are generally not synchronous with those on previous whorls and are rather strongly oblique to coiling axis. There are 5–6 ribs per 0.5 mm on penultimate

whorl in abapertural view. Spiral raised striae moderately strong on earlier whorls of teleoconch; 4–5 rows of spiral raised striae present per 100 µm at 300x magnification. Aperture is not tilted to coiling axis, is circular, with entire apertural rim. Aperture is more or less centered to coiling axis in apertural view. Peristome is double, in lateral view consisting of 1–2 stronger and more distant and several dense, delicate previous peristomes. Parietal margin of peristome is attached to spire. Inner peristome forms narrow continuous polished callus. Inner peristome entire, appressed to penultimate whorl, outer peristome discontinuous along parietal margin. Palatal margin of inner peristome is sinuous. Columella is smooth, with small glossy median knob. Operculum unknown. Differential diagnosis: This species is rather similar to several congeners, differential features as in Table 1.

Table 1. Papuan species of *Palaina* s. l. similar to *P. sarmi* sp. nov. and their distinctive features.

Species	Feature	Feature in <i>P. sarmi</i> sp. nov.
<i>P. albrechti</i> Greke, 2017	H = 1.25–1.3 mm, W = 0.7–0.75 mm; axial ribs dense, ~17–19 ribs per 0.5 mm in abapertural view; more than 25 rows of spiral raised striae per 100 µm; peristome multilamellate (described as "triple" in Greke (2017)); columella with inconspicuous median angulation	H = 2.6 mm, W = 1.4 mm; axial ribs less dense, ~5–6 ribs per 0.5 mm in abapertural view; about 4–5 rows of spiral raised striae per 100 µm; peristome double; columella with small knob
<i>P. beilanensis</i> Preston, 1913	H = 1.8–1.9 mm, W = 0.8 mm; ~15 ribs per 0.5 mm in abapertural view; peristome triple; peristome not sinuous; distribution – Obi Islands (North Moluccas)	H = 2.6 mm, W = 1.4 mm; ~5–6 ribs per 0.5 mm in abapertural view; peristome double; palatal margin of inner peristome sinuous; distribution – North New Guinea
<i>P. biroi</i> Soós, 1911	H = 1.3–1.6 mm, W = 0.8–0.9 mm; abrupt changes in axial ribbing pattern of teleoconch at place of constriction; axial ribs dense, ~12–16 ribs per 0.5 mm in abapertural view; more than 15 rows of spiral raised striae per 100 µm; columella with inconspicuous median angulation	H = 2.6 mm, W = 1.4 mm; no abrupt changes in axial ribbing pattern of teleoconch; ~5–6 ribs per 0.5 mm in abapertural view; about 4–5 rows of spiral raised striae per 100 µm; columella with small knob
<i>P. flavocylindrica</i> Greke, 2017	H = 1.5–1.7 mm, W = 0.8 mm; axial ribs nearly straight; axial ribs dense, ~16–18 ribs per 0.5 mm in abapertural view; more than 27 rows of spiral raised striae per 100 µm; columella simple	H = 2.6 mm, W = 1.4 mm; axial ribs sinuous at least on their upper and lower edges; ~5–6 ribs per 0.5 mm in abapertural view; about 4–5 rows of spiral raised striae per 100 µm; columella with small knob
<i>P. iha</i> Greke, 2017	H = 1.35–1.4 mm, W = 0.7 mm; constriction area is free of axial ribs; axial ribs dense, ~14–16 ribs per 0.5 mm in abapertural view; more than 24 rows of spiral raised striae per 100 µm; outer peristome more strongly developed than inner one; columella simple	H = 2.6 mm, W = 1.4 mm; constriction area with somewhat denser axial ribs than surrounding area; ~5–6 ribs per 0.5 mm in abapertural view; about 4–5 rows of spiral raised striae per 100 µm; both inner and outer peristomes similarly strongly developed; columella with small knob



Table 1 (continuation)

<i>P. insulana</i> Greķe, 2017	H = 1.8–1.95 mm, W = 0.95–1 mm; axial ribs are much coarser and twice as widely spaced on penultimate and ultimate whorls; ~8–9 ribs per 0.5 mm in abapertural view; ~20 rows of spiral raised striae per 100 µm; peristome multilamellate (described as "triple" in Greķe (2017)); columella simple	H = 2.6 mm, W = 1.4 mm; axial ribs not twice as distant on last whorls; ~5–6 ribs per 0.5 mm in abapertural view; 4–5 rows of spiral raised striae per 100 µm; peristome double; columella with small knob
<i>P. lengguru</i> Greķe, 2017	H = 1.3–1.4 mm, W = 0.75–0.8 mm; abrupt changes in axial ribbing pattern of teleoconch - ribs twice as distant starting from constriction; ~13–15 ribs per 0.5 mm in abapertural view; peristome thin in lateral view; palatal margin of inner peristome not sinuous; columella simple	H = 2.6 mm, W = 1.4 mm; no abrupt changes in axial ribbing pattern of teleoconch; ~5–6 ribs per 0.5 mm in abapertural view; peristome moderately broad in lateral view; palatal margin of inner peristome sinuous; columella with small knob
<i>P. minuscularia</i> Greķe, 2017	H = 1.3–1.8 mm, W = 0.7–0.9 mm; constriction is poorly defined by weak sutural impression above it; ~25–28 ribs per 0.5 mm in abapertural view; ~12 rows of spiral raised striae per 100 µm; palatal margin of inner peristome not sinuous; columella with small basal knob	H = 2.6 mm, W = 1.4 mm; constriction is well defined by presence of a vague impression, somewhat denser pattern of axial ribs and presence of a deep impression on suture above it; ~5–6 ribs per 0.5 mm in abapertural view; about 4–5 rows of spiral raised striae per 100 µm; palatal margin of inner peristome sinuous; columella with small median knob
<i>P. psittricha</i> Greķe, 2017	H = 1.65–1.8 mm, W = 0.9–1 mm; ultimate whorl is slightly narrower than penultimate in apertural view; abrupt changes in axial ribbing pattern of teleoconch - ribs become twice as distant beyond constriction; axial ribs dense, ~9–10 ribs per 0.5 mm in abapertural view; more than 20 rows of spiral raised striae per 100 µm; aperture is slightly shifted left to coiling axis in apertural view; operculum is derivative - high (tuba-like), with several layers of concentric lines on outer surface	H = 2.6 mm, W = 1.4 mm; ultimate whorl nearly as wide as penultimate in apertural view; no abrupt changes in axial ribbing pattern of teleoconch; axial ribs less dense, ~5–6 ribs per 0.5 mm in abapertural view; about 4–5 rows of spiral raised striae per 100 µm; aperture is centered to coiling axis in apertural view; operculum unknown
<i>P. waigeo</i> Greķe, 2017	H = 1.3–1.35 mm, W = 0.7 mm; axial ribs dense, ~17–19 ribs per 0.5 mm in abapertural view; more than 15 rows of spiral raised striae per 100 µm; no columellar knob present	H = 2.6 mm, W = 1.4 mm; axial ribs sparser, ~5–6 ribs per 0.5 mm in abapertural view; about 4–5 rows of spiral raised striae per 100 µm; columellar knob present

Ecology: Specimens sampled from wet leaf litter in primary lowland (elevation 50–65 m) rainforest on a steep limestone ridge.

Distribution: Northern New Guinea (Map 1).

***Palaina* (s. l.) *saxatilis* sp. nov.** (Figs 11, 25–26)
<http://zoobank.org/7D36EDCC-6D8D-48B8-A17A-50F9EBABB027>

Holotype NME: INDONESIA E, New Guinea, Papua Prov., Sentani 30 km W, road to Nimbokrang, River Armo valley, 02°34'26"S, 140°14'21"E, 62–65 m, 31.III.2018, wet limestone rocks at riverbank.

Paratypes 30 specimens [5 MBBJ, 13 NME & 12 KGC]: same data as holotype [one paratype shell is badly

broken].

Derivatio nominis: Named from Latin “saxatilis” (living on rocks, rock-dwelling) since this species was sampled from mossy rocks on a riverbank.

Measurements: Holotype H = 1.7 mm, W = 0.95 mm, HW = 0.9 mm, AD = 0.5 mm. Selected paratypes H = 1.6 mm, W = 0.8 mm, HW = 0.8 mm, AD = 0.55 mm; H = 1.65 mm, W = 0.7 mm, HW = 0.6 mm, AD = 0.45 mm; H = 1.65 mm, W = 0.9 mm, HW = 0.9 mm, AD = 0.5 mm.

Description: Shell very small, white, pale yellow (on older whorls) to pale brownish, sinistral, elongate cylindrical with flattened apex. Shell of six



moderately strongly convex whorls, $1\frac{1}{2}$ embryonic whorl is microscopically pitted. Suture is deeply impressed. Ultimate whorl is about as wide as penultimate whorl in apertural view. Umbilicus is closed in adults. Constriction is vaguely defined by presence of slight impression on shell wall and more deeply impressed suture above constriction. Position of constriction is above columellar side of aperture. Teleoconch is sculptured with moderately dense, straight axial ribs. Ribs become coarser and 2–2.5x more distant on last half whorl, but without abrupt changes in ribbing pattern. Ribs are not synchronous with those on previous whorls and are slightly oblique to coiling axis. There are 10–12 ribs per 0.5 mm on penultimate whorl in abapertural view. Spiral raised striae of teleoconch delicate and dense, 10–12 rows of spiral raised striae present per 100 μ m at 300x magnification. Aperture is not tilted to coiling axis, is circular and with entire apertural rim. Aperture is more or less

centered to coiling axis in apertural view. Peristome is double, in lateral view consisting of 2–4 rather strong and densely placed previous peristomes. Parietal margin of peristome is attached to spire. Inner peristome forms narrow, continuous, polished callus. Outer peristome is broadly discontinued parietally. Margins of both inner and outer peristomes are not sinuous. Columella is smooth, with large median knob, which is curved interiad. Operculum derivative, with low concentric ridges on outer surface.

Differential diagnosis: This is one of the smallest diplommatinids in the Papuan Region and Wallacea. The new species is rather similar to several congeners, differential features as in Table 2.

Ecology: Specimens sampled from wet, mossy rocks and from leaf litter in river valley, in disturbed lowland (elevation 62–65 m) rainforest.

Distribution: Northern New Guinea (Map 1).

Table 2. Papuan species of *Palaina* s. l. similar to *P. saxatilis* sp. nov. and their distinctive features.

Species	Feature	Feature in <i>P. saxatilis</i> sp. nov.
<i>P. albrechti</i> Greke, 2017	H = 1.25–1.3 mm, W = 0.7–0.75 mm; axial ribs dense, ~17–19 ribs per 0.5 mm in abapertural view; more than 25 rows of spiral raised striae per 100 μ m; peristome multilamellate; columella with inconspicuous median angulation	H = 1.6–1.7 mm, W = 0.8–0.95 mm; ~10–12 ribs per 0.5 mm in abapertural view; ~10–12 rows of spiral raised striae per 100 μ m; peristome double; columella with conspicuous median knob
<i>P. beilanensis</i> Preston, 1913	shell slender and more regularly cylindrical; ~15 ribs per 0.5 mm in abapertural view; peristome multilamellate (outer peristome consists of two nearly same strong lamellae of previous peristomes); columella not studied; distribution – Obi Islands (North Moluccas)	shell less slender, tapered to apex; ~10–12 ribs per 0.5 mm in abapertural view; peristome double; columella with conspicuous median knob; distribution – North New Guinea
<i>P. biroi</i> Soós, 1911	abrupt changes in axial ribbing pattern of teleoconch at place of constriction; axial ribs dense, ~12–16 ribs per 0.5 mm in abapertural view; more than 15 rows of spiral raised striae per 100 μ m; columella with inconspicuous median angulation	no abrupt changes in axial ribbing pattern of teleoconch; ~10–12 ribs per 0.5 mm in abapertural view; ~10–12 rows of spiral raised striae per 100 μ m; columella with conspicuous median knob
<i>P. flavocylindrica</i> Greke, 2017	axial ribs dense, ~16–18 ribs per 0.5 mm in abapertural view; more than 27 rows of spiral raised striae per 100 μ m; columella simple	~10–12 ribs per 0.5 mm in abapertural view; ~10–12 rows of spiral raised striae per 100 μ m; columella with conspicuous median knob
<i>P. iha</i> Greke, 2017	H = 1.35–1.4 mm, W = 0.7 mm; constriction area is free of axial ribs; axial ribs dense, ~14–16 ribs per 0.5 mm in abapertural view; more than 24 rows of spiral raised striae per 100 μ m; outer peristome is more strongly developed than inner one; columella simple	H = 1.6–1.7 mm, W = 0.8–0.95 mm; constriction area with axial ribs; ~10–12 ribs per 0.5 mm in abapertural view; ~10–12 rows of spiral raised striae per 100 μ m; both inner and outer peristomes similarly strongly developed; columella with conspicuous median knob
<i>P. insulana</i> Greke, 2017	axial ribs becoming much coarser and twice as distant on penultimate and ultimate whorls; ~8–9 ribs per 0.5 mm in abapertural view; ~20 rows of spiral raised striae per 100 μ m; peristome multilamellate; columella simple	axial ribs not becoming twice as distant on last whorls except beyond constriction; ~10–12 ribs per 0.5 mm in abapertural view; ~10–12 rows of spiral raised striae per 100 μ m; columella with conspicuous median knob



Table 2 (continuation)

<i>P. lengguru</i> Greke, 2017	H = 1.3–1.4 mm, W = 0.75–0.8 mm; abrupt changes in axial ribbing pattern of teleoconch - ribs 2x more distant starting from constriction; ~13–15 ribs per 0.5 mm in abapertural view; peristome thin in lateral view; columella simple	H = 1.6–1.7 mm, W = 0.8–0.95 mm; no abrupt changes in axial ribbing pattern of teleoconch; ~10–12 ribs per 0.5 mm in abapertural view; peristome (space between inner and outer peristome) moderately broad in lateral view; columella with conspicuous median knob
<i>P. minuscularia</i> Greke, 2017	H = 1.3–1.8 mm, W = 0.7–0.9 mm; ~25–28 ribs per 0.5 mm in abapertural view; columella with small basal knob	H = 1.6–1.7 mm, W = 0.8–0.95 mm; ~10–12 ribs per 0.5 mm in abapertural view; columella with conspicuous median knob
<i>P. psittricha</i> Greke, 2017	operculum is derivative - high (tuba-like), with several layers of concentric lines on outer surface; ultimate whorl is slightly narrower than penultimate in apertural view; abrupt changes in axial ribbing pattern of teleoconch - ribs becoming twice more distant beyond constriction; axial ribs dense, more than 20 rows of spiral raised striae per 100 µm; aperture is slightly shifted left to coiling axis in apertural view	operculum with low concentric ridges, lacking tuba; ultimate whorl nearly same width as penultimate in apertural view; no abrupt changes in axial ribbing pattern of teleoconch; ~10–12 rows of spiral raised striae per 100 µm; aperture more or less centered to coiling axis in apertural view
<i>P. sarmi</i> sp. nov. (described above)	H = 2.6 mm, W = 1.4 mm; constriction is well defined by presence of a vague impression, somewhat denser pattern of axial ribs and presence of a deep impression on suture above it; axial ribs less dense, ~5–6 ribs per 0.5 mm in abapertural view; ~4–5 rows of spiral raised striae per 100 µm; palatal margin of inner peristome sinuous; columella with small median knob	H = 1.6–1.7 mm, W = 0.8–0.95 mm; constriction poorly defined; ~10–12 ribs per 0.5 mm in abapertural view; ~10–12 rows of spiral raised striae per 100 µm; palatal margin of inner peristome not sinuous; columella with conspicuous median knob
<i>P. waigeo</i> Greke, 2017	H = 1.3–1.35 mm, W = 0.7 mm; ~17–19 ribs per 0.5 mm in abapertural view; more than 15 rows of spiral raised striae per 100 µm; no columellar knob present	H = 1.6–1.7 mm, W = 0.8–0.95 mm; ~10–12 ribs per 0.5 mm in abapertural view; ~10–12 rows of spiral raised striae per 100 µm; columellar knob present

Updated key to the Papuan Diplommatinidae

The only existing key to the Papuan and Wallacean diplommatinids species was published recently (Greke 2017). Herewith I provide modifications to my *Palaina* key to include new species described in the present paper and one correction. All plates and figures quoted in the modified couplets of the key are referring to the original key of Greke (2017).

Considering the fact that during the present study a dextral *Palaina consobrina* specimen was discovered, users of the key (Greke 2017) must be aware of this fact and have to assess this species in both branches of the key – the dextral and the sinistral ones (couplet 1).

Correction: the couplet 71 of the key (Greke 2017: 275) must be read:

- 71 Shell apex conical, shell is not regularly cylindrical ..
..... 72
– Shell apex is flattened, shell is regularly cylindrical
..... 73

The couplet 64 is modified to include *P. cenderawasih* sp. nov.:

- 64 Constriction situated on same axis with parietal side of aperture, it is defined by denser axial ribs and a sutural impression; shell H ~3.8 mm; axial ribs spaceous, not or slightly sinuous *P. glabella*
– Constriction situated on same axis with columellar side of aperture, it is defined by denser axial ribs and a sutural impression; shell H ~2.1–2.3 mm; axial ribs spaceous, not or slightly sinuous *P. obiensis*
– Constriction situated on same axis with columellar side of the aperture; shell H 4.4 mm; axial ribs dense,



strongly sinuous on older whorls, nearly straight on the pen- and ultimate whorl *P. cenderawasih* sp. nov.

The couplet 60 is modified to include *P. evanescens* sp. nov.:

60 Peristome double; outer peristome expands strongly beyond inner one, broadly encircles aperture and is widely discontinued parietally 61
– Peristome double; outer peristome is not or partly expanding beyond inner one, not encircling aperture (if encircling, then is not extraordinary broad) 62
– Peristome simple *P. evanescens* sp. nov.

The couplet 41 is modified to include *P. kagainisi* sp. nov.:

64 There are ~6 ribs per 1 mm on penultimate whorl, constriction situated on same axis with parietal side of aperture, it is defined by slightly denser axial ribs, there are 4–5 delicate but distinct spiral raised striae per 100 µm, peristome double, shell H ~3.8 mm *P. glabella*
– There are ~8–9 ribs per 1 mm on penultimate whorl, constriction situated on same axis with parietal side of aperture, it is defined by twice denser axial ribs, spiral raised striae or striations almost absent (only tracks of them visible by 500x magnification), peristome multilamellate, shell H ~2.3 mm ... *P. kagainisi* sp. nov.
– There are ~8–10 ribs per 1 mm on penultimate whorl, constriction situated on same axis with columellar side of aperture, it is defined by denser axial ribs, there are more than 10 spiral raised striae per 100 µm (on older teleoconch whorls, spiral sculpture not present on ultimate whorl), peristome double, shell H ~2.1–2.3 mm *P. obiensis*

The couplet 41 is modified to include *P. pallgergelyi* sp. nov.:

41 Axial ribs straight or oblique against coiling axis on penultimate whorl in apertural view, ribs are not strongly sinuous; shell H not exceeding 3.6 mm 42
– Axial ribs strongly oblique against coiling axis on penultimate whorl in apertural view and are distinctly sinuous; shell H ~3.9 mm; spiral raised striae delicate but distinct on penultimate and ultimate whorls; there are 5–6 axial ribs per 0.5 mm on abapertural side of penultimate whorl; columellar knob large, somewhat shifted down closer to base of columella and turned outwards towards aperture *P. consobrina*
– Axial ribs strongly oblique against coiling axis on penultimate whorl in apertural view; axial ribs stronger sinuous on older whorls than on penultimate and ultimate ones; shell H >4 mm; there are 9–12 axial ribs per 0.5 mm on abapertural side of penultimate whorl; columellar knob large, positioned medially on columella, not or indistinctly turned outwards towards aperture
..... *P. pallgergelyi* sp. nov.

Since operculum is not known in *P. sarmi* sp. nov., this species is included into two branches of the modified key:

68 Shell rather slender but not conical, penultimate and ultimate whorls nearly equally wide in apertural view (Greke (2017): Plate 31 fFigs 1–3); axial ribs strong and moderately spaceous, ~5–6 ribs per 0.5 mm on penultimate whorl; spiral raised striae not present; aperture slightly shifted left to coiling axis ... *P. adelpha*
– Shell less slender, fusiform, with maximum width on penultimate whorl (in apertural view) and with broadly conical apex (Greke (2017): Plate 45 Figs 1–6); axial ribs less strong and denser, ~9–10 ribs per 0.5 mm on penultimate whorl; spiral raised striae delicate and dense, >20 rows of spiral raised striae per 100 µm; aperture slightly shifted left to coiling axis
..... *P. psittricha*
– Shell slender, fusiform, penultimate and ultimate whorls nearly equally wide in apertural view; axial ribs moderately spaceous, ~5–6 ribs per 0.5 mm; ~4–5 rows of spiral raised striae per 100 µm; aperture more or less centered to coiling axis *P. sarmi* sp. nov.

74 Columella without knob; there are significantly less than 25 axial ribs per 0.5 mm 75
– Columella with basal knob; two rather strong lamellae between inner and outer peristome; 12–13 rows of spiral raised striae per 100 µm (measured above the aperture); 25–28 axial ribs per 0.5 mm
..... *P. minuscularia*
– Columella with delicate median knob; ~5–6 axial ribs per 0.5 mm; ~4–5 rows of spiral raised striae per 100 µm *P. sarmi* sp. nov.

The minute shell of *P. saxatilis* sp. nov. has axial ribbing pattern that is significantly more distant on the last half whorl and strong median columellar knob:

69 Columella is straight, slightly curved or twisted, without median knob 70
– Columella with large, median backwards directed knob (Fig. 53); shell H 2.7–2.9 mm; ~6–7 axial ribs per 0.5 mm, ribs becoming denser on ultimate whorl in apertural view *P. doberai*
– Columella with a large median knob; shell H 1.6–1.7 mm; ~10–12 axial ribs per 0.5 mm, ribs not becoming denser on ultimate whorl in apertural view
..... *P. saxatilis* sp. nov.

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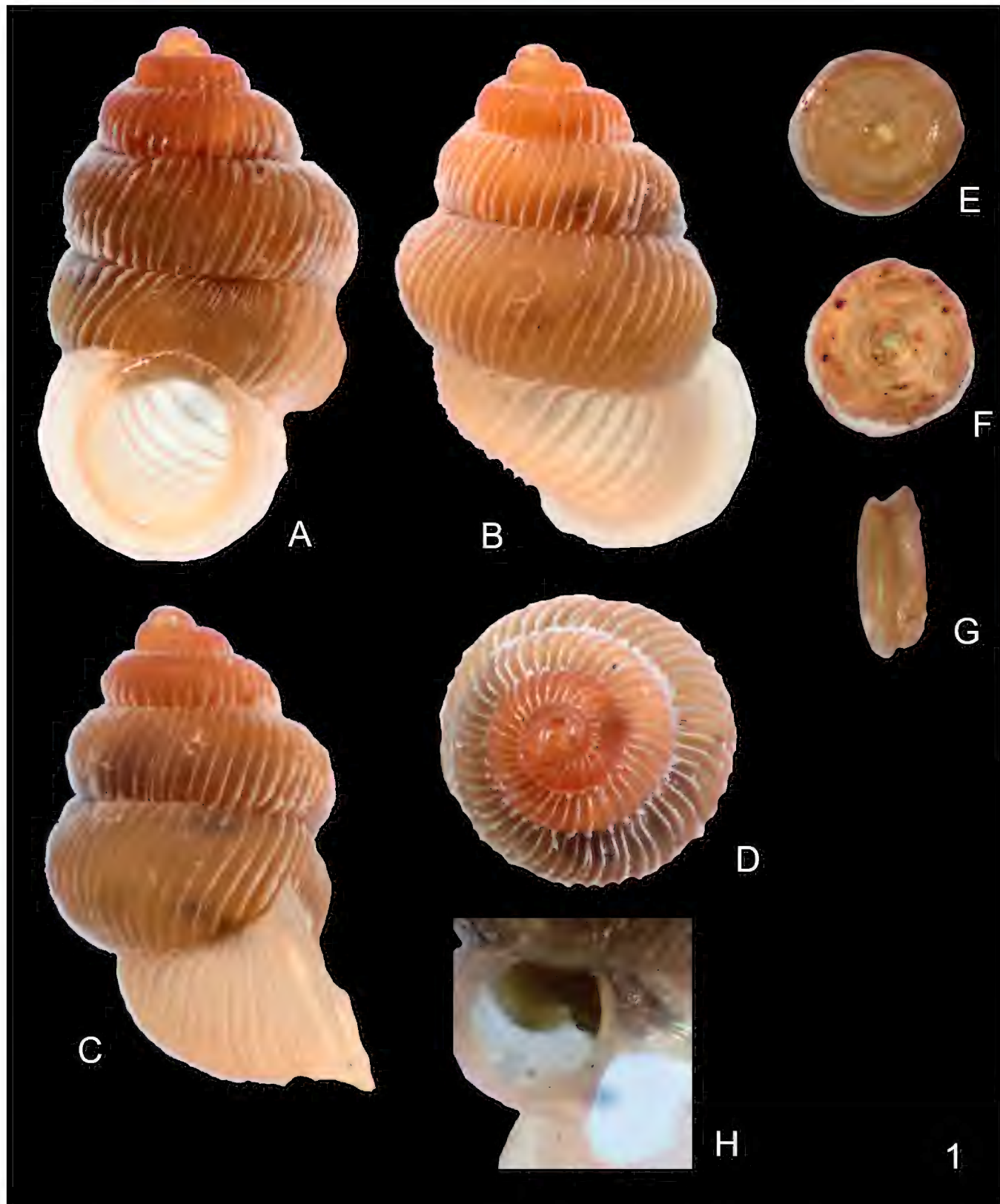
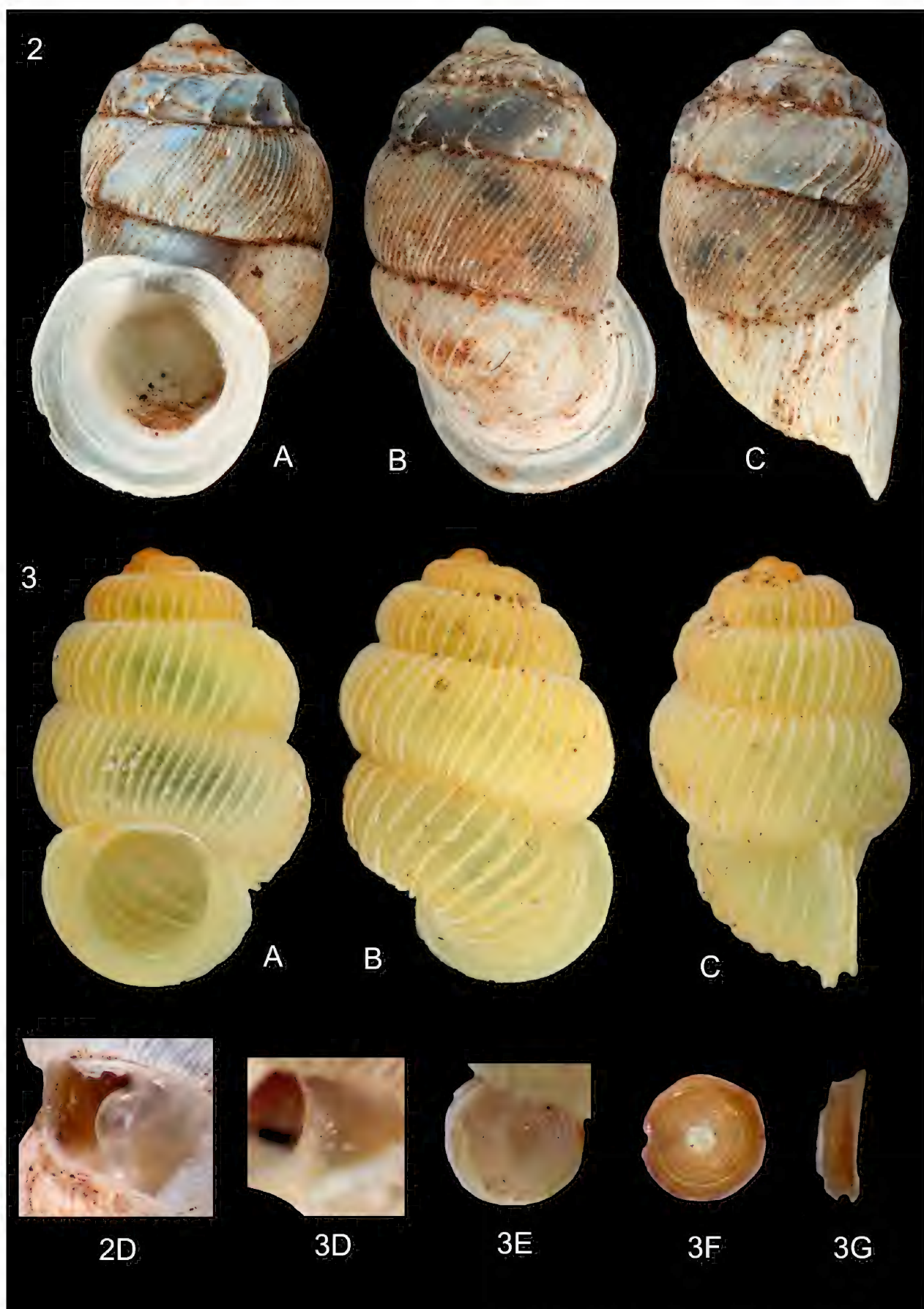


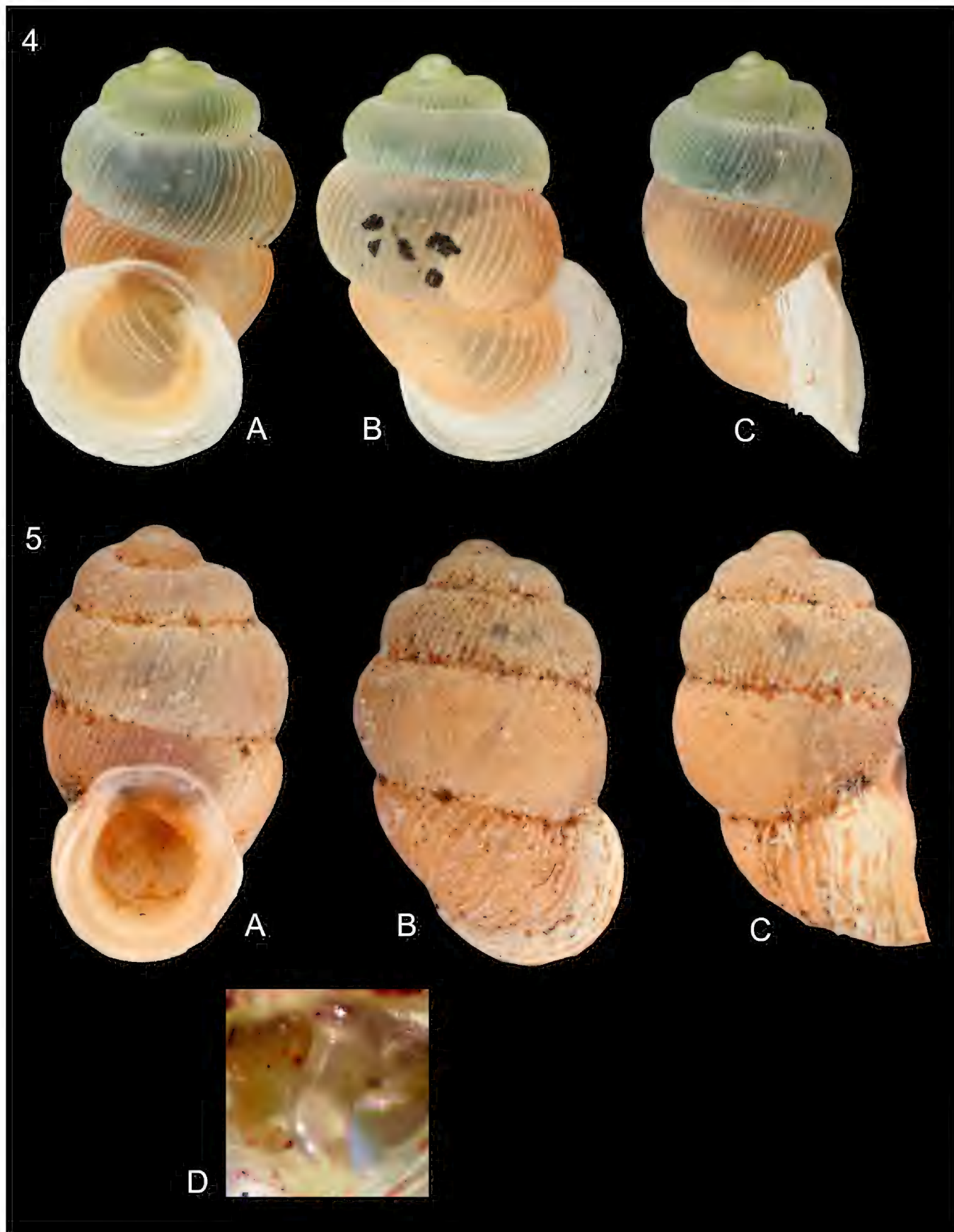
Figure 1. *Palaina* (s. l.) *citrinella* van Benthem Jutting, 1963, specimens from River Armo valley, Papua. A – Apertural view; B – Abapertural view; C – Lateral view; D – Apical view; E–G – Operculum, inner (E) and outer surface (F) and lateral (G) view; H – Columella [not to scale].





Figures 2–3. Papuan *Palaina* (s. l.) O. Semper, 1865 species. 2 – *P. cupulifera* van Benthem Jutting, 1963, specimen from ~34 km ENE Biak, Biak Is. A – Apertural view; B – Abapertural view; C – Lateral view; D – Columella; 3 – *P. glabella* van Benthem Jutting, 1963, specimen from ~53.5 km NNW Biak, Biak Is. A – Apertural view; B – Abapertural view; C – Lateral view; D – Columella; E–G – Operculum, outer (E) and inner surface (F) and lateral (G) view [not to scale].





Figures 4–5. Papuan *Palaina* (s. l.) O. Semper, 1865 species. 4 – *P. inconspicua* van Benthem Jutting, 1963, specimen from near Urfu village, Biak Is. A – Apertural view; B – Abapertural view; C – Lateral view; 5 – *P. liliputana* van Benthem Jutting, 1963, specimen from 56 km NNW Biak, Biak Is. A – Apertural view; B – Abapertural view; C – Lateral view; D – Columella [not to scale].



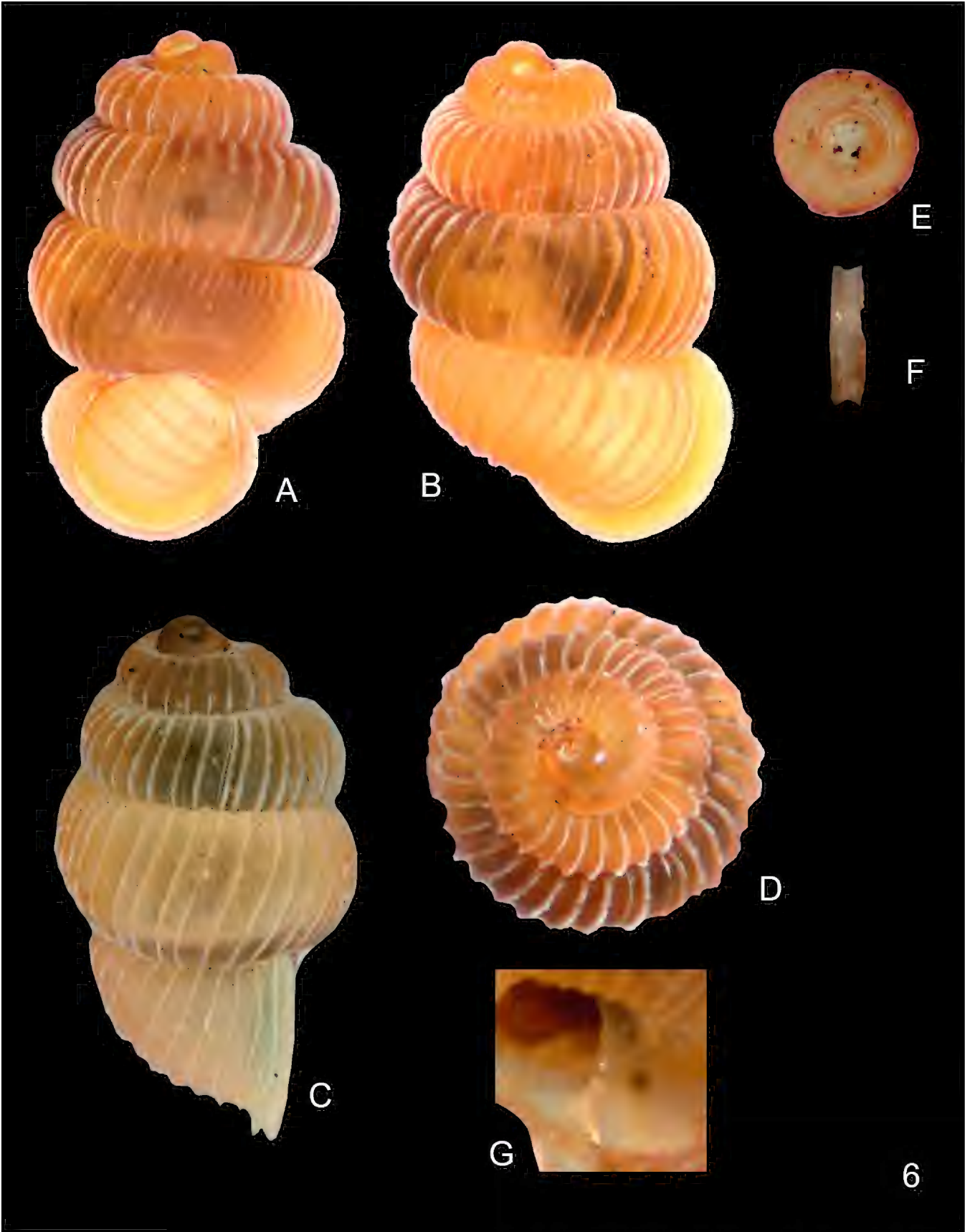


Figure 6. *Palaina* (s. l.) *cenderawasih* sp. nov., paratypes from near Biak Bird park, Biak Is. A – Apertural view; B – Abapertural view; C – Lateral view; D – Apical view; E–F – operculum, internal surface (E) and lateral view (F); G – Columella [not to scale].



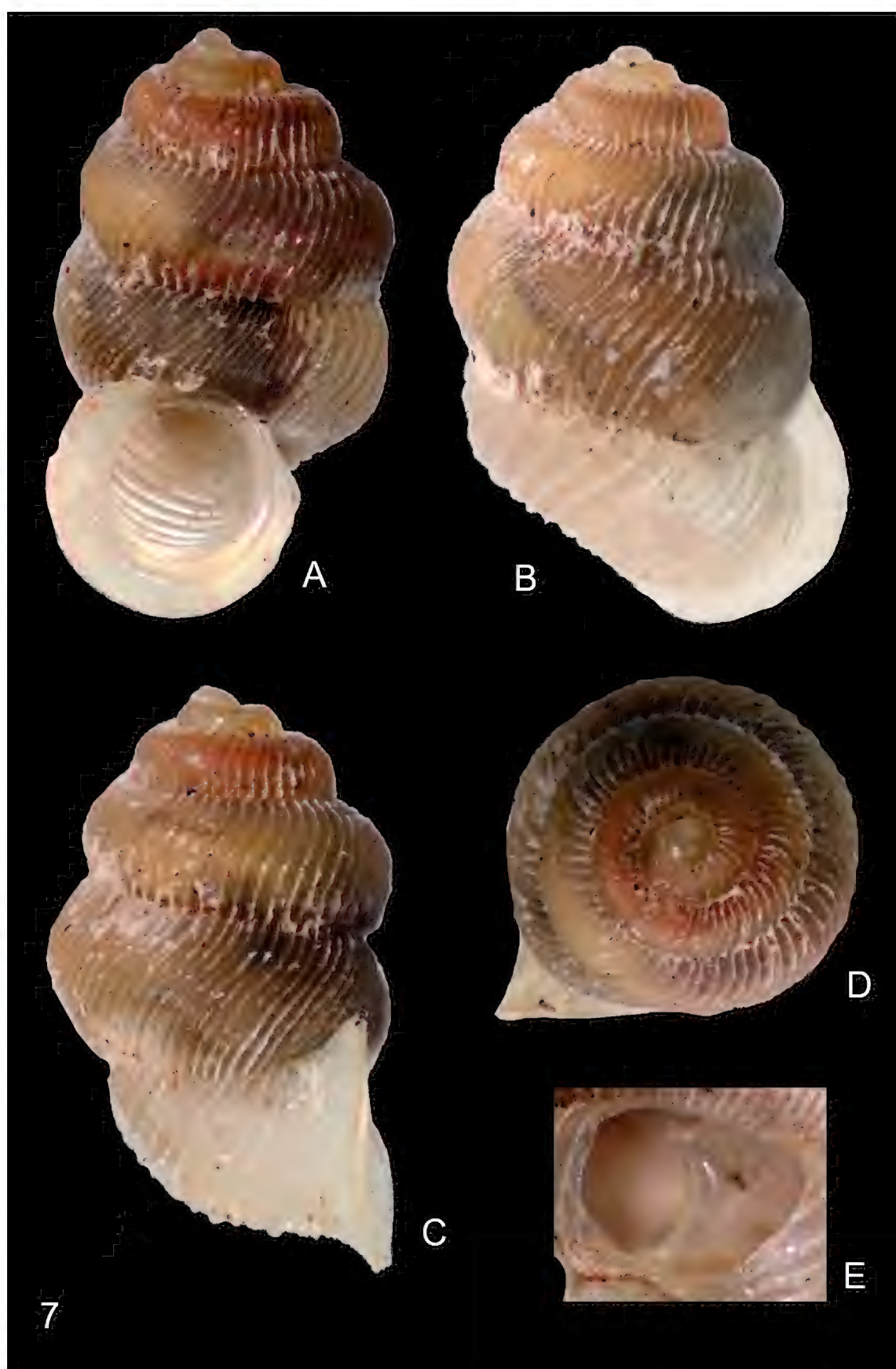


Figure 7. *Palaina* (s. l.) *evanescens* sp. nov., holotype. A – Apertural view; B – Abapertural view; C – Lateral view; D – Apical view; E – Columella [not to scale].



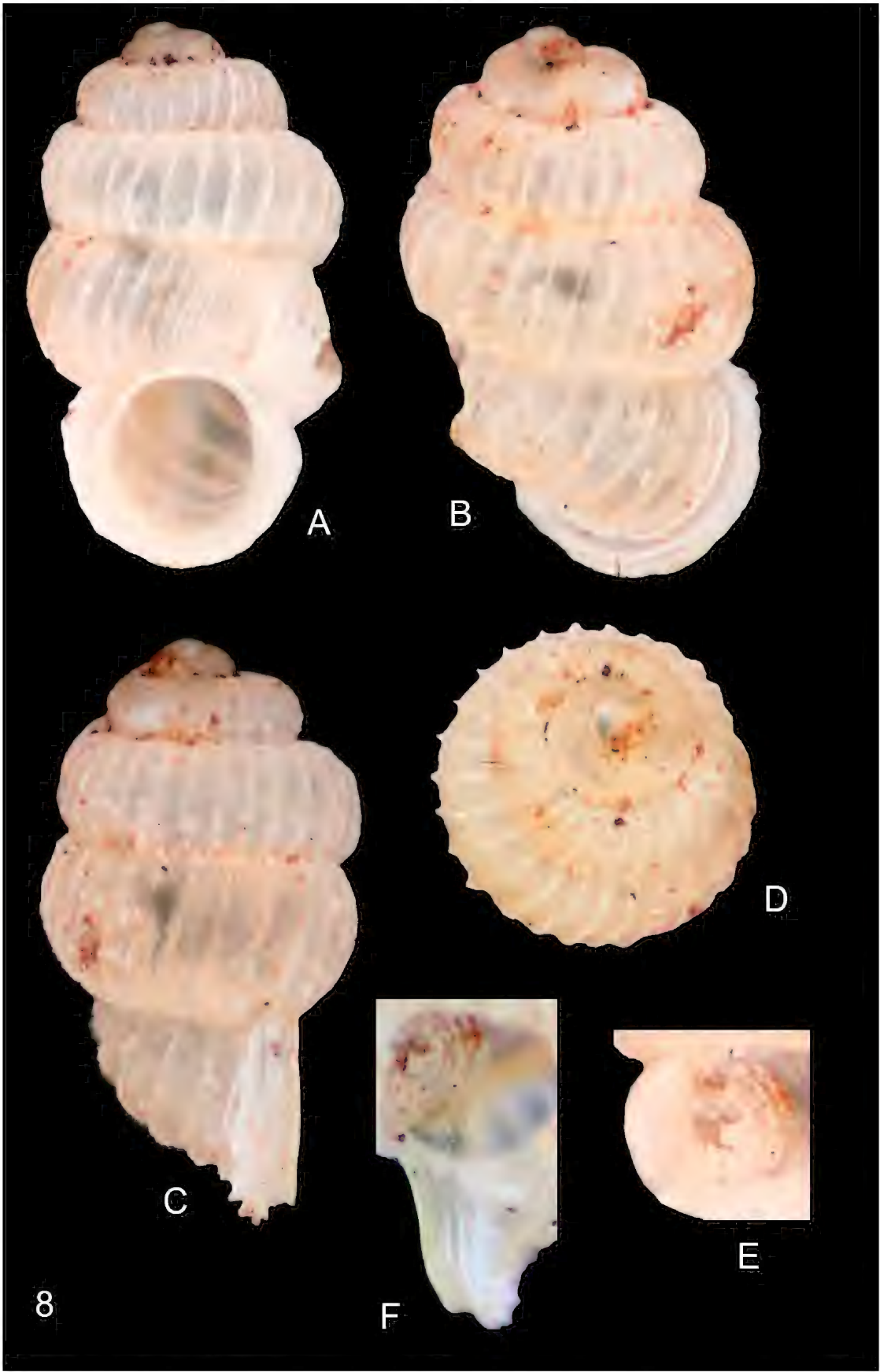


Figure 8. *Palaina* (s. l.) *kagainisi* sp. nov., holotype. A – Apertural view; B – Abapertural view; C – Lateral view; D – Apical view; E – Operculum, outer surface; F – Columella [not to scale].



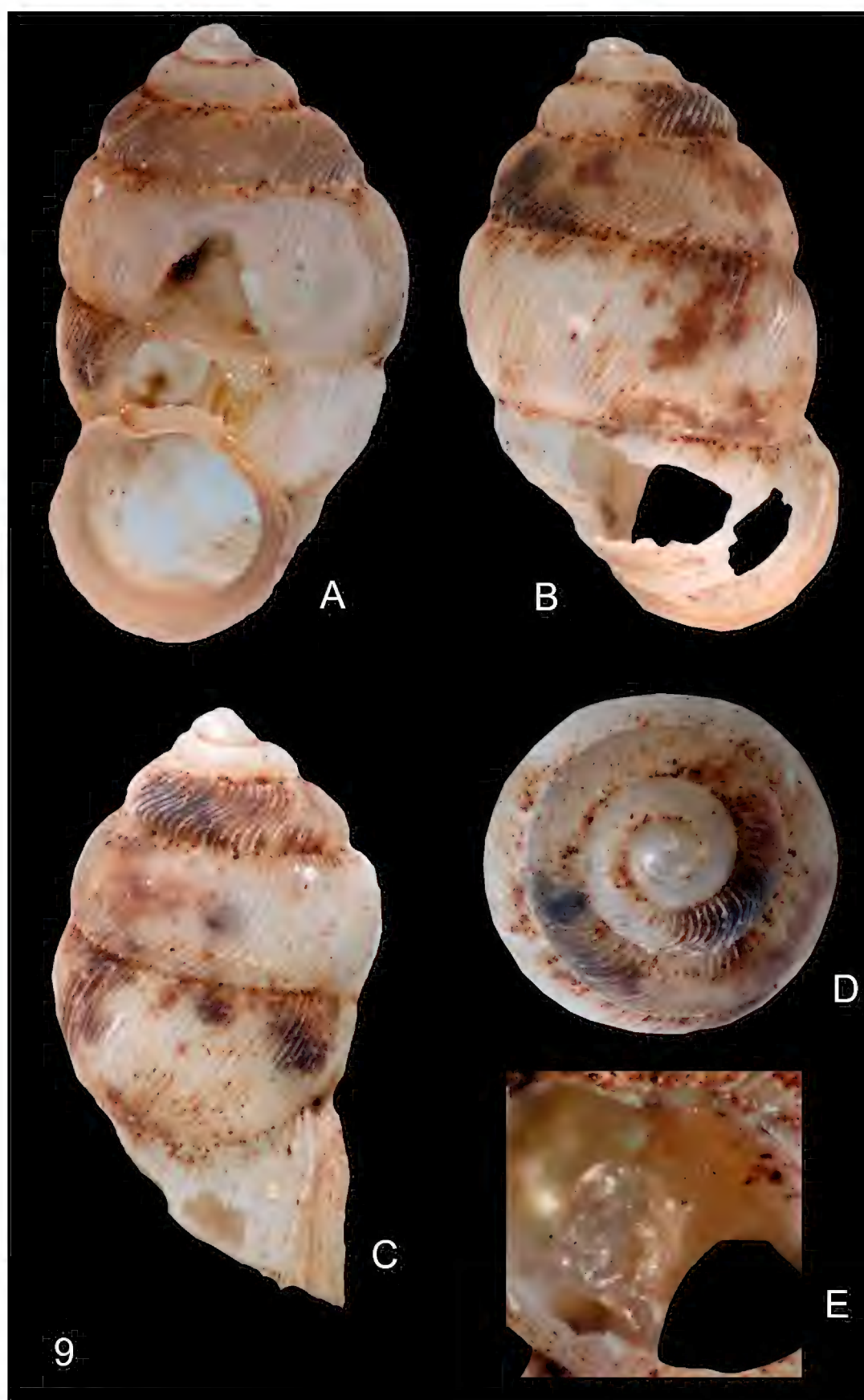


Figure 9. *Palaina* (s. l.) *pallgergelyi* sp. nov., holotype. A – Apertural view; B – Abapertural view; C – Lateral view; D – Apical view; E – Columella [not to scale].



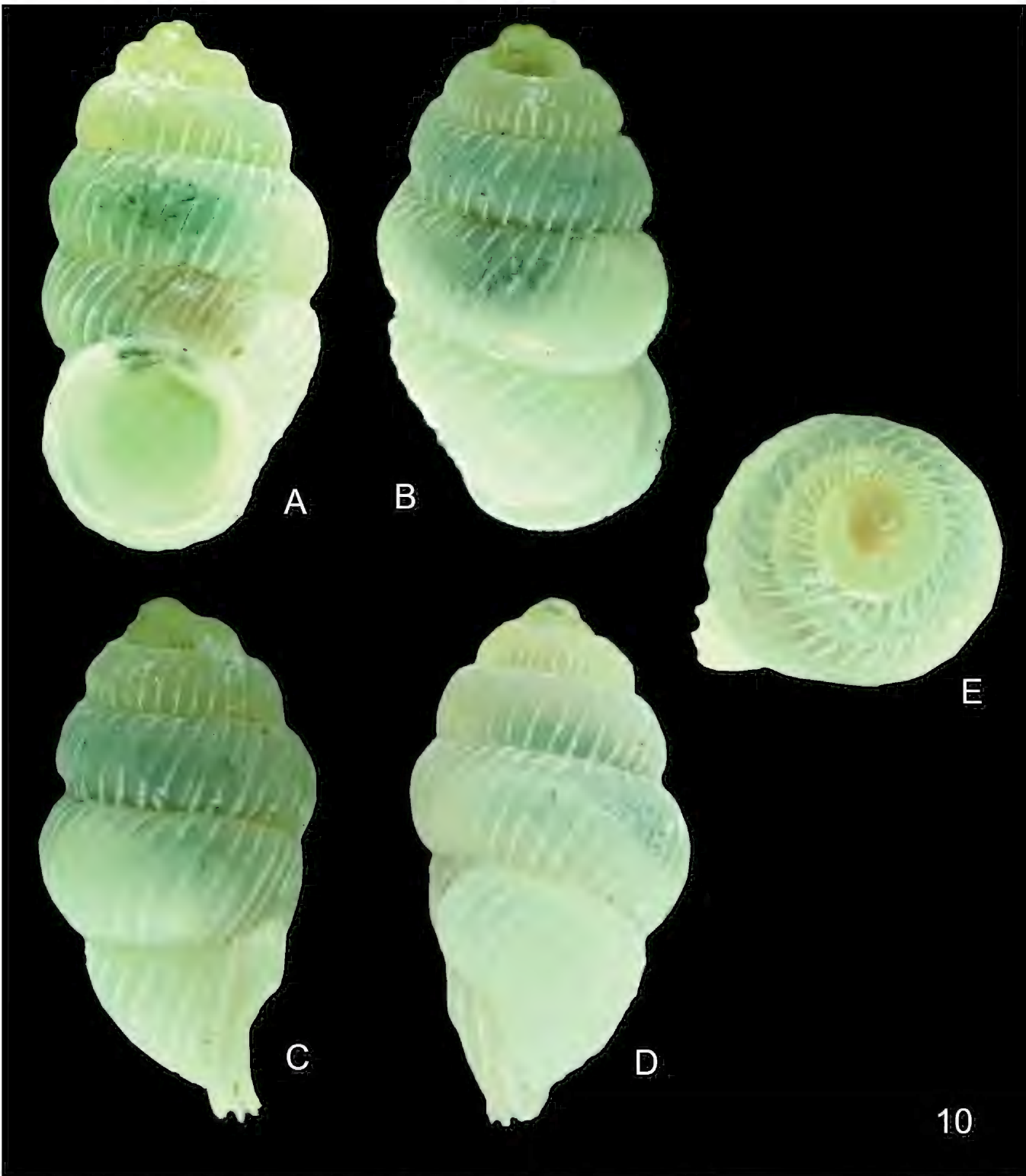


Figure 10. *Palaina* (s. l.) *sarmi* sp. nov., holotype. A – Apertural view; B – Abapertural view; C–D Lateral view; E – Apical view [not to scale].



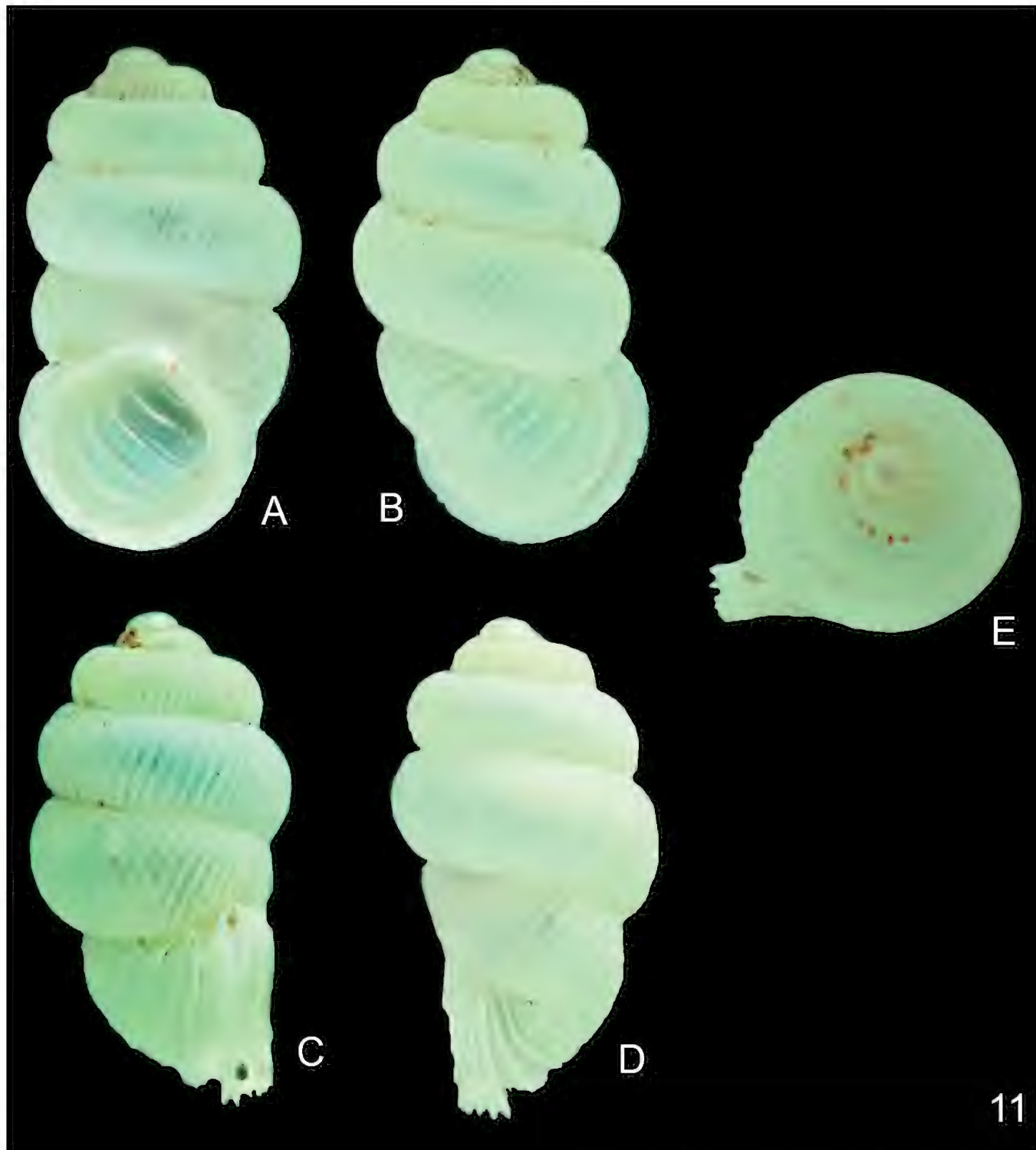
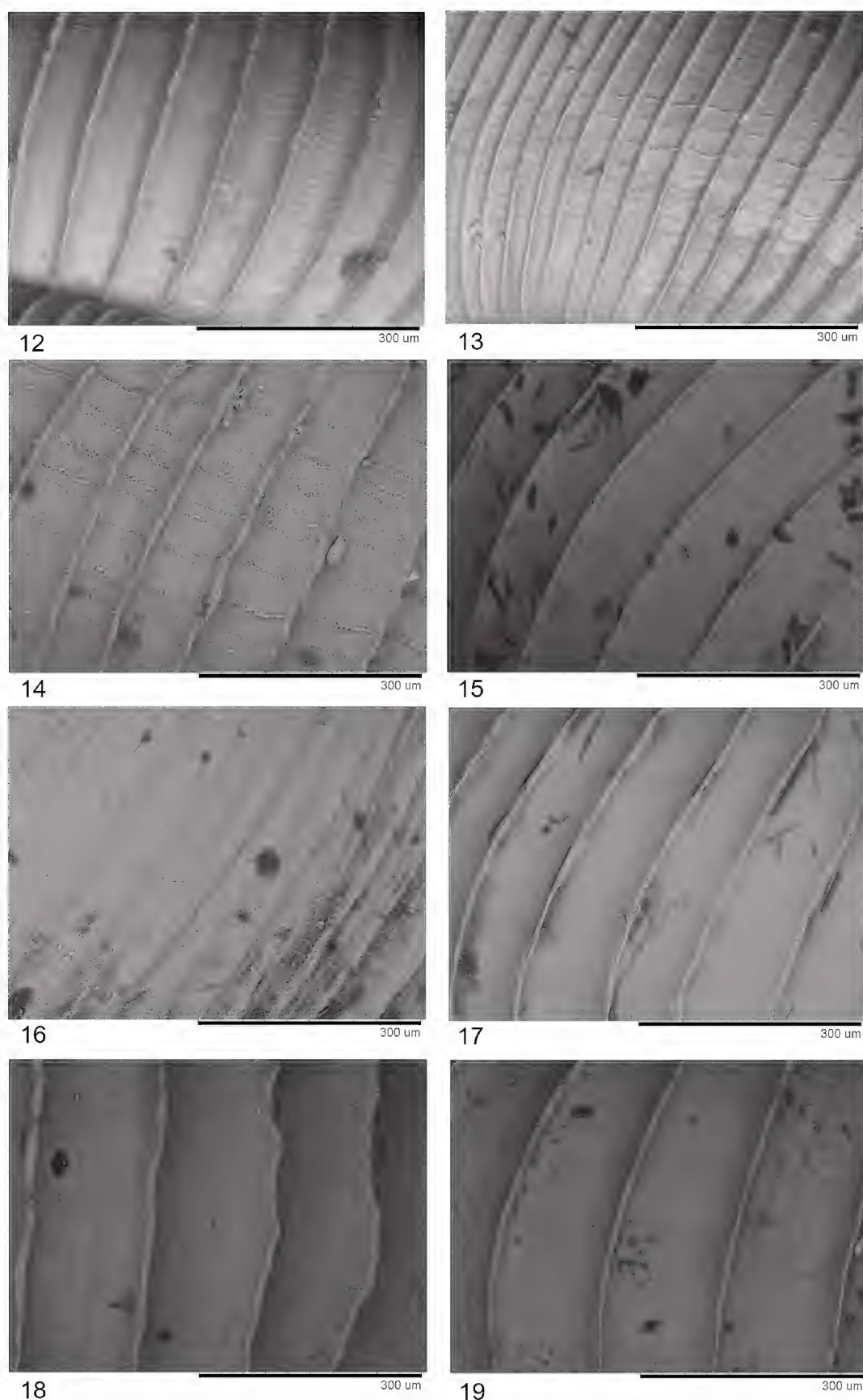


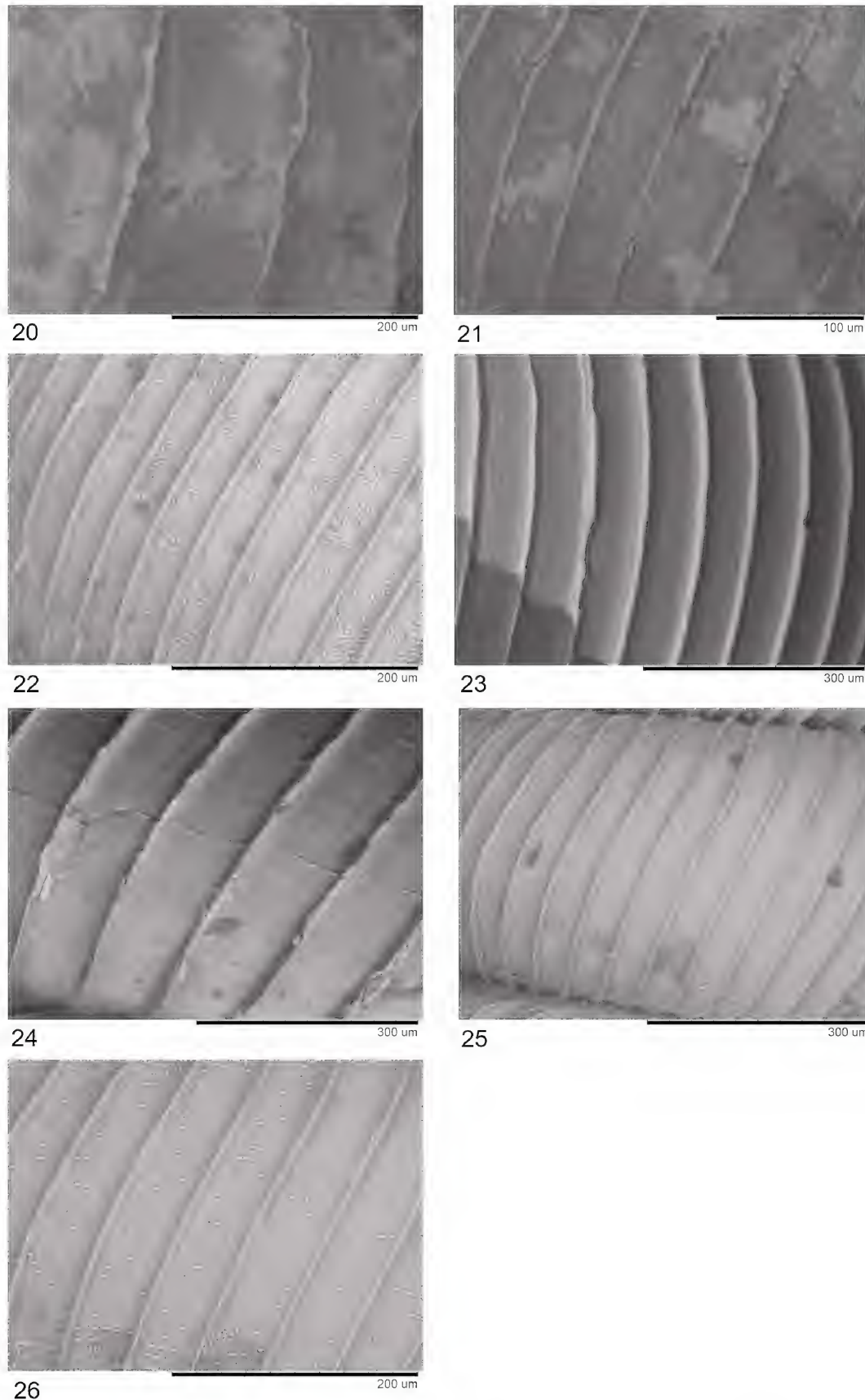
Figure 11. *Palaina* (s. l.) *saxatilis* sp. nov., holotype. A – Apertural view; B – Abapertural view; C–D Lateral view; E – Apical view [not to scale].





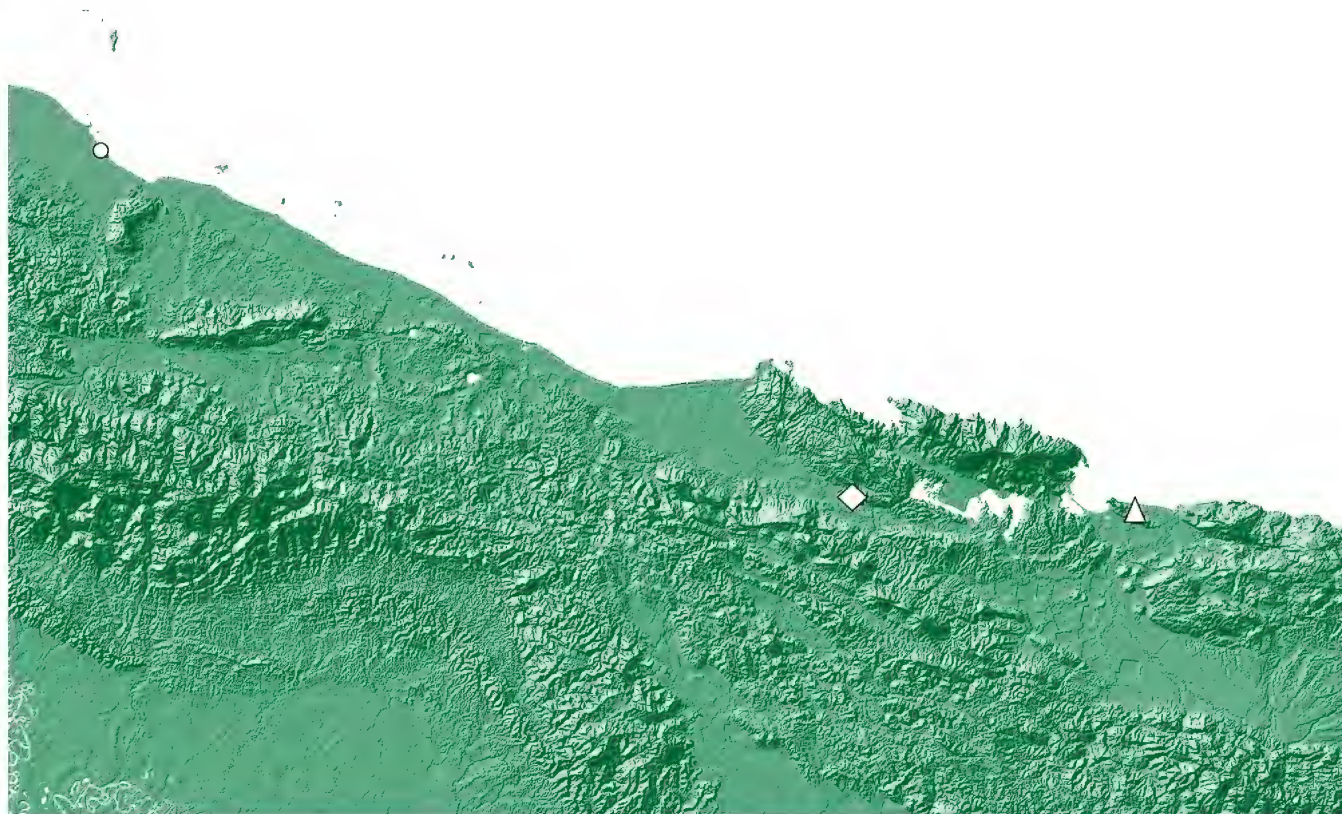
Figures 12–19. Micrographs of the Papuan *Palaina* (s. l.) O. Semper, 1865 (300x magnification). 12–13 – *P. cenderawasih* sp. nov., paratype, penultimate (12) and ultimate (13) whorl; 14 – *P. citrinella* van Benthem Jutting, 1963; 15 – *P. consobrina* van Benthem Jutting, 1963; 16 – *P. cupulifera* van Benthem Jutting, 1963; 17 – *P. evanescens* sp. nov., holotype; 18 – *P. glabella* van Benthem Jutting, 1963; 19 – *P. inconspicua* van Benthem Jutting, 1963.





Figures 20–26. Micrographs of the Papuan *Palaina* (s. l.) O. Semper, 1865. 20–21 – *P. kagainisi* sp. nov., holotype, 500x (20) and 600x (21) magnification; 22 – *P. liliputana* van Benthem Jutting, 1963 (500x); 23 – *P. repandostoma* van Benthem Jutting, 1963 (300x); 24 – *P. sarmi* sp. nov., holotype (300x); 25–26 – *P. saxatilis* sp. nov., paratype, 300x (25) and 500x (26).





Map 1. Localities of *Palaina* (s. l.) O. Semper, 1865 species in northern New Guinea. Circle – *P. sarmi* sp. nov.; diamond – *P. citrinella* van Benthem Jutting, 1963 and *P. saxatilis* sp. nov.; triangle – *P. consobrina* van Benthem Jutting, 1963 and *P. evanescens* sp. nov. (prepared with ArcGIS 10.3).



Map 2. Localities of *Palaina* (s. l.) O. Semper, 1865 species on Biak, Cenderawasih Bay Islands. Square and diamonds (empty and filled) – *P. liliputana* van Benthem Jutting, 1963; Diamonds (empty and filled) – *P. glabella* van Benthem Jutting, 1963; Filled diamond – *P. kagainisi* sp. nov. and *P. pallgergelyi* sp. nov.; Five-point star – *P. cenderawasih* sp. nov. and *P. inconspicua* van Benthem Jutting, 1963; Four-point star – *P. cenderawasih* sp. nov. and *P. repandostoma* van Benthem Jutting, 1963; Circle – *P. cupulifera* van Benthem Jutting, 1963 (prepared with ArcGIS 10.3).

